TAM AKADEMİ DERGİSİ
JOURNAL OF TAM ACADEMY

e-ISSN : 2822-4493
Yıl/Year : Mayıs / May 2025
Cilt/Volume : 4
Sayı/Issue : 1

Trends in Using Artificial Intelligence in Social and Natural Science Research

Yapay Zekânın Sosyal ve Doğa Bilimleri Araştırmalarında Kullanımındaki Eğilimler

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Derleme Makale
Review Article

Geliş tarihi/Received:
14.04.2025

Son revizyon teslimi/Last revision received:
25.03.2025

Kabul tarihi/Accepted:
28.05.2025

Yayın tarihi/Published:
31.05.2025

Atıf/Citation:
At-Thaariq, Z. Z., Surahman, E., Jaradat, M. S. K., & Mellyana, I. M. (2025). Trends in using artificial ıntelligence in social and natural science research. *TAM Akademi Dergisi*, 4(1), 100-132. https://doi.org/10.58239/tamde.2025.01.006.x

DOI:
10.58239/tamde.2025.01.006.x

ABSTRACT

This article discusses trends in the use of artificial intelligence (AI) in social sciences and natural sciences research. The introduction highlights how AI has evolved into an essential tool in both fields, addressing the limitations of traditional methods in social sciences and accelerating data analysis in natural sciences. The research method used is bibliometric analysis, with data collected from Google Scholar using keywords related to AI in social and natural sciences. Relevant articles were selected through a content evaluation and exclusion process, resulting in 1,000 social science publications and 999 natural science publications, which were further analyzed using VOSviewer with such as being outside the five-year range (published from 2020 to 2025). The study's findings indicate that in social sciences, AI is widely used to enhance research effectiveness through faster data processing, particularly in higher education and social policy analysis. Additionally, AI studies in social sciences are expanding, focusing on ethics, regulation, and human-AI interaction. In natural sciences, AI plays a crucial role in resource management, environmental research, and the healthcare industry, including disease diagnosis and drug development. Recent trends also show an increasing use of large language models (LLMs) and natural language processing (NLP) in scientific research. The study concludes that AI has become a key element in both social and natural science research. Recommendations for social science researchers include further exploration of AI's impact on psychology, law, and education, as well as the use of bibliometric methods. Meanwhile, natural science researchers are advised to focus on improving AI transparency, developing more accurate technologies, and applying AI in environmental and industrial research. Interdisciplinary collaboration is necessary to ensure AI development remains ethical and inclusive.

Keywords: Artificial Intelligence, Social Science, Natural Science, Bibliometric Review, Research

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ÖZ

Bu makale, sosyal bilimler ve doğa bilimleri araştırmalarında yapay zekanın (AI) kullanım eğilimlerini ele almaktadır. Giriş kısmında, yapay zekanın her iki alanda da nasıl temel bir araç haline geldiği vurgulanmakta, sosyal bilimlerdeki geleneksel yöntemlerin sınırlılıklarını ele aldığı ve doğa bilimlerinde veri analizini hızlandırdığı belirtilmektedir. Araştırma yöntemi olarak bibliyometrik analiz kullanılmış, veriler sosyal ve doğa bilimlerinde yapay zekâ ile ilgili anahtar kelimeler kullanılarak Google Scholar'dan toplanmıştır. İlgili makaleler içerik değerlendirmesi ve hariç tutma süreci aracılığıyla seçilmiş, sonuçta 1.000 sosyal bilim yayını ve 999 doğa bilimleri yayını elde edilmiş ve bunlar beş yıllık aralığın dışında kalmak (2020-2025 yılları arasında yayınlanmış) gibi kriterlerle VOSviewer kullanılarak daha detaylı analiz edilmiştir. Çalışmanın bulguları, sosyal bilimlerde yapay zekanın özellikle yükseköğretim ve sosyal politika analizinde daha hızlı veri işleme yoluyla araştırma etkinliğini artırmak için yaygın olarak kullanıldığını göstermektedir. Ayrıca, sosyal bilimlerdeki yapay zekâ çalışmaları genişlemekte ve etik, düzenleme ve insan-AI etkileşimi konularına odaklanmaktadır. Doğa bilimlerinde ise yapay zekâ, kaynak yönetimi, çevre araştırmaları ve hastalık teşhisi ile ilaç geliştirme dahil olmak üzere sağlık sektöründe kritik bir rol oynamaktadır. Son eğilimler ayrıca bilimsel araştırmalarda büyük dil modellerinin (LLM'ler) ve doğal dil işlemenin (NLP) artan kullanımını göstermektedir. Çalışma, yapay zekanın hem sosyal hem de doğa bilimleri araştırmalarında anahtar bir unsur haline geldiği sonucuna varmaktadır. Sosyal bilim araştırmacılarına yönelik öneriler arasında yapay zekanın psikoloji, hukuk ve eğitim üzerindeki etkisinin daha fazla araştırılması ve bibliyometrik yöntemlerin kullanılması yer almaktadır. Doğa bilimleri araştırmacılarına ise yapay zekâ şeffaflığının iyileştirilmesi, daha doğru teknolojilerin geliştirilmesi ve yapay zekanın çevre ve endüstriyel araştırmalarda uygulanmasına odaklanmaları tavsiye edilmektedir. Yapay zekâ gelişiminin etik ve kapsayıcı kalmasını sağlamak için disiplinler arası zekâ gereklidir.

Anahtar Kelimeler: Yapay Zekâ, Sosyal Bilimler, Doğa Bilimleri, Bibliyometrik İnceleme, Araştırma

Introduction

A mathematician and computer scientist who was also the inventor of the first modern digital computer, Alan Turing, posed a fundamental question: "Can machines think?" (Turing, 1950). According to him, this question must begin with defining the meaning of "machine" or "thinking." From this perspective, he introduced a structured experiment involving three roles: a man, a woman, and an interrogator. The interrogator is placed in a separate room from the other two individuals, with the goal of determining which of them is male and which is female. The interrogator knows them only as X and Y and, at the end of the game, states, "X is A and Y is B" or "X is B and Y is A." Turing called this structure the imitation game. This game served as the foundational inspiration for the development of a system known as Artificial Intelligence (AI) (Forrester, 2025; Hodges & Hofstadter, 2014). Artificial Intelligence is referred to as an interrogator, which functions to recognize, determine, and express structured commands.

AI refers to the simulation of human intelligence by systems or machines. The goal of AI is to develop machines that can think like humans and imitate human behavior, including understanding, reasoning, learning, planning, and predicting. Intelligence is one of the main characteristics that distinguish humans from animals. With the ongoing industrial revolution, more types of machines are continuously replacing human labor at all levels of society, and the eventual replacement of human resources by machine intelligence is the next major challenge to be addressed (Armstrong & Lorch, 2020; Dai et al., 2024; Tapia, 2024; Xu et al., 2021).

The application of AI techniques has permeated our daily lives (Morande et al., 2025; Stone et al., 2022; Wiederhold, 2025). Most current AI systems are specifically designed for predetermined tasks (Ashrafian, 2015; Jiang et al., 2022; Scherer, 2015). AI is primarily used to increase productivity and make tasks easier. AI has been proven to absorb and analyze more data in a shorter time than humans (Bouhouita-Guermech et al., 2023; Davenport, 2018). Thus, AI is highly beneficial in performing various tasks, including research.

AI has undergone many adjustments throughout its development, and this also includes ethical concerns (Guleria et al., 2023; Harlow, 2018). These ethical concerns involve legal boundaries in the academic and research fields, which are still in early development stages, the protection of individual rights from data misuse, and the legality of data. The accuracy of the available data also needs improvement to prevent the broader spread of inaccurate data. AI users in academic and research fields need to be cautious, think critically, and increase their awareness of privacy and ethical risks.

Recently, there has been a resurgence in the field of explainable artificial intelligence, as researchers and practitioners strive to bring more transparency to their algorithms. Much of this research focuses on providing explicit explanations of decisions or actions to human observers, and it is uncontroversial to state that studying how humans explain things to one another can serve as a useful starting point for explanations in artificial intelligence (Madumal et al., 2019; Miller, 2019; Shin et al., 2021).

The research areas we discuss focus on two domains: social sciences, and natural sciences. Traditional social science research has relied on methods such as surveys, interviews, and observational studies—approaches that often have limitations, including sample bias, subjective interpretation, and resource constraints. The emergence of AI has introduced transformative capabilities that overcome these limitations and open new avenues for social inquiry. AI's ability to process large volumes of data with exceptional speed and accuracy has paved the way for new research methodologies that far exceed conventional approaches (English et al., 2022; Phillips et al., 2024; Raman, 2023; Sebastian et al., 2025). The natural sciences have also undergone significant transformation through AI integration, with applications ranging from environmental research and resource management to physics. AI has become an essential tool for processing large environmental data sets and deciphering complex relationships between system variables (Mottaghi-Dastjerdi & Soltany-Rezaee-Rad, 2024; Senyapar, 2024; Zhu et al., 2023). Thus, the impact on scientific discovery has led to the emergence of a new conceptual framework regarding the use of AI as an emerging general method of invention, which possesses the power of innovative research methodologies. AI and research methods will complement each other and drive a paradigm shift in decision-making processes (Bianchini et al., 2022; Pal, 2023).

Shao et al (2021) found that the phenomenon of "research convergence" is becoming increasingly apparent in AI-based research today due to the highly similar research interests of experts across different regions. They discovered that the best works dominate the AI academic world, as these works attract significant attention. Essentially, scientists must contend with various research constraints, including limited time, fixed budgets, and restricted cognitive capacity. AI tools are seen as a solution to overcome these barriers, enabling scientists to become more productive (in terms of producing more scientific work) and more objective (free from bias and subjectivity) (Messeri & Crockett, 2024).

Artificial intelligence is not a psychological construct because it does not originate from the same cognitive or emotional processes as humans (Gignac & Szodorai, 2024). Instead, AI can be considered a computational construct, derived from simulations of human thought and decision-making, facilitated by data processing, machine learning techniques, and algorithmic principles (Prasad et al., 2023; Schoser, 2023). Constructs are essential tools in psychological research and theory, as they help conceptualize and organize complex psychological phenomena in a way that allows for systematic investigation, prediction, and explanation (Borsboom, 2023). In practice, psychological constructs are inferred from responses to various stimuli and performance in task execution (Strauss & Smith, 2009).

Therefore, this study poses the following questions:

1. What are the emerging trends in AI usage in social research?
2. What are the emerging trends in AI usage in natural science research?
3. What recommendations should be provided to researchers in both social and natural sciences regarding the use of AI in their studies?

Building on these questions, this research offers a new perspective on understanding the dynamics of AI usage in social and natural science research. A comparative and in-depth analysis of AI utilization trends in these three domains highlights adoption patterns, challenges, and emerging ethical and methodological implications. Because AI is anticipated not merely to assist researchers, but to autonomously generate hypotheses, design experiments, and drive scientific discovery itself. While previous research has generally focused on a single domain or examined AI in general, this study connects how AI functions differently in social and natural science research and how interdisciplinary approaches can enhance its effectiveness.

1. Method

Bibliometric analysis is a popular and rigorous method for exploring and analyzing large volumes of scientific data. This method allows us to uncover the nuances of a field's evolution while highlighting emerging areas within that field (Donthu et al., 2021). The emergence of bibliometric techniques has created new opportunities for researchers to study and understand critical research domains (Hulland, 2024). More importantly, the popularity of bibliometric analysis in research is not a mere trend but rather a reflection of its utility in (1) handling large volumes of scientific data and (2) generating high research impact (Donthu et al., 2021). This appeal has led the authors to adopt this approach as a method in their study.

According to Garfield (2006), bibliometric research enables the historical examination and structural mapping of a field, the flow of information within that field, journal impact, and citation status of publications over an extended period. This definition illustrates the unique role of bibliometric as a research method for evaluating a specific research domain (C. Wang et al., 2024). Bibliometric methods are inherently quantitative but are used to make statements about qualitative characteristics. In fact, the primary goal of all types of bibliometric practices is to transform something intangible (scientific quality) into a manageable entity (Wallin, 2005). This approach provides a broader perspective on the structure, dynamics, and interconnections between various scientific elements in a field (Öztürk et al., 2024).

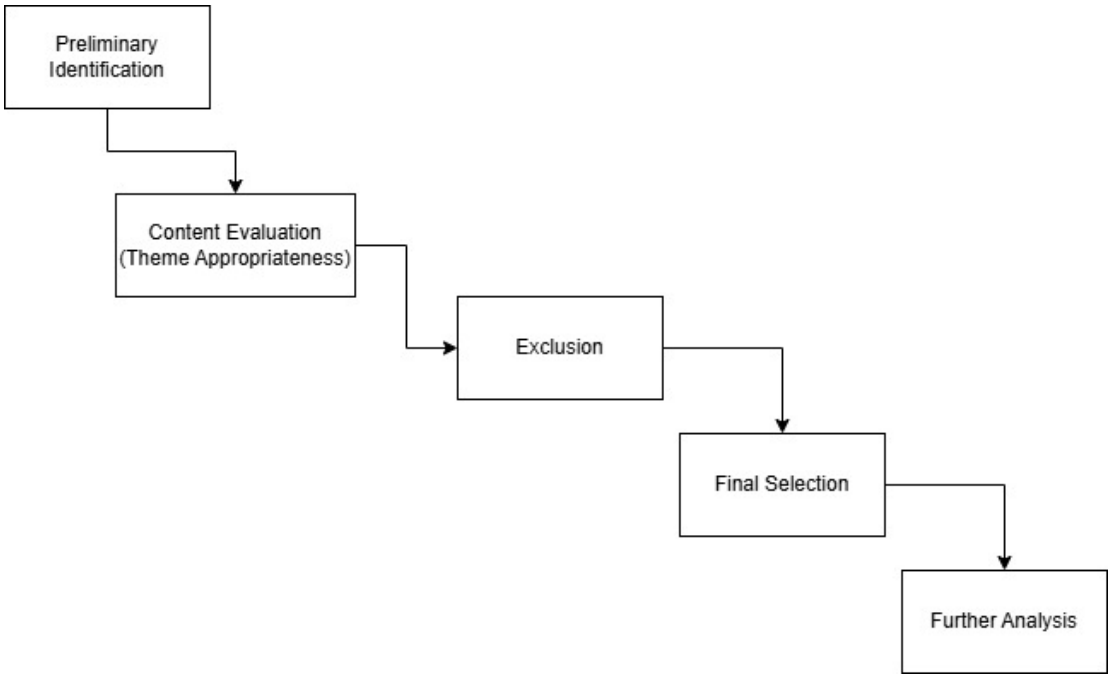

Figure 1: Bibliometric Study Procedures

In bibliometric studies, the process of identifying and selecting literature is carried out systematically to ensure that only relevant and high-quality sources are analyzed further. The first stage in this process is Preliminary Identification. At this stage, researchers conduct a literature search using the academic database Google Scholar. Relevant keywords are used to gather as many potential references as possible related to the research topic, namely **"artificial intelligence"** with the keyword **"social science"** and **"artificial intelligence"** with the keyword **"natural science"**. This stage aims to obtain a broad scope of previously conducted research.

After the preliminary identification, the next stage is Content Evaluation (Theme Appropriateness). In this stage, each retrieved article is evaluated to ensure its relevance to the research focus. Articles that do not discuss the appropriate theme, use an unsuitable methodology, or have too broad a scope may be excluded from the candidate list. This evaluation is crucial for filtering sources that truly contribute to the study being conducted.

The next stage is Exclusion. Articles that do not meet specific criteria, such as being outside the five-year range (published before 2020 or after 2025), written in an incomprehensible language, or deemed less relevant after further evaluation, are removed from the list. This process helps narrow down the literature so that only research that aligns with the study's objectives is retained.

Based on the exclusion results, 1,000 published articles related to social science research and 999 published articles related to natural science research were selected for analysis in this study.

After the exclusion process, the next stage is Final Selection. At this stage, only articles that have passed the various previous selection phases are chosen for further analysis. The articles that reach this stage are considered to have significant contributions to understanding the studied field. To facilitate this process, the authors used VOSviewer as a supporting application.

The final stage is Further Analysis. The selected articles are then analyzed in-depth to identify research trends, relationships between previous studies, and research gaps that could serve as opportunities for future research. In bibliometric studies, this analysis may include co-citation mapping, keyword analysis, or classification based on methodology and research findings. This process helps provide a deeper understanding of the development of a scientific field and the direction of future research.

2. Result

2.1. Distribution of Data Related to AI in Social Science Research

The dataset for "social science" records 1,000 journal publications with a total of 72,991 citations from 2020 to 2025, indicating an average of 14,598.2 citations per year and 72.99 citations per journal. With an h-index of 81 and a g-index of 109, this data reflects a high academic impact. The average number of citations per author reaches 29,841.64, while the average number of publications per author is 511.69. Other indicators, such as the e-index and hm-index, also highlight the relevance and influence of the research within the academic community. The detailed distribution will be further explained in relation to (1) the distribution of publication years and (2) the distribution of journal publishers.

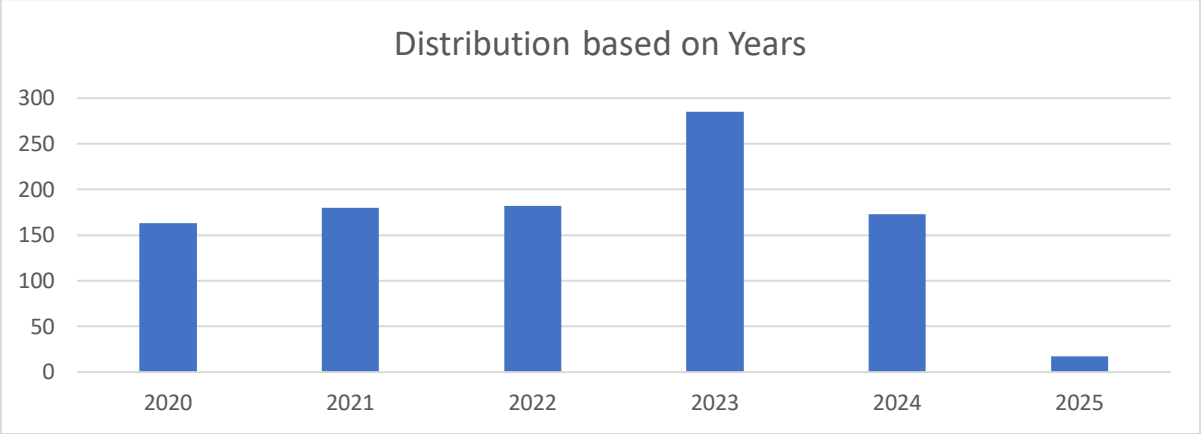

Figure 2: Distribution of Social Science Articles based on Years

Figure 2 illustrates a total of 1,000 articles published between 2020 and 2025, highlighting the trend of scientific publication growth over the years. The distribution of publications reveals that the highest number of articles was recorded in 2023, with 285 publications, accounting for 28.50% of the total dataset. This peak suggests that research productivity reached its highest level during this year, reflecting an increasing engagement in scientific dissemination within this period. The publication trend started with 163 articles (16.30%) in 2020, marking the beginning of the observed period. This number gradually increased to 180 articles (18.00%) in 2021, followed by another rise to 182 articles (18.20%) in 2022. The steady growth in 2021 and 2022 indicates a sustained momentum

in academic research output, likely driven by increased funding, research initiatives, or advancements in specific scientific fields. In 2023, the publication count surged to 285 articles, a significant increase compared to previous years. This growth could be attributed to various factors, such as expanded research collaborations, new funding opportunities, or a rise in open-access publications. However, after reaching this peak, the number of publications slightly declined in 2024, with 173 articles (17.30%). While still a considerable amount, this decrease suggests possible changes in research focus, funding availability, or publication policies. Meanwhile, 2025 currently has the lowest number of recorded publications, with only 17 articles (1.70%). This low count is likely due to the ongoing nature of data collection, as not all publications for this year have been finalized. As the year progresses, the number of recorded articles may increase, potentially altering the current distribution trend. Overall, the publication trend between 2020 and 2025 demonstrates a steady increase in research output, reaching its highest level in 2023, before experiencing a slight decline in the following years. This pattern may be influenced by several factors, including shifts in global research priorities, funding dynamics, and journal acceptance rates. The observed trends provide valuable insights into the evolving landscape of scientific publications, offering a foundation for further analysis on the factors affecting research productivity.

Table 1: Top 10 publishers in the Social Science category for this study

No	Publisher	Total Articles
1	Springer	118
2	Elsevier	75
3	Taylor & Francis	47
4	Wiley Online Library	42
5	Books Google	29
6	Academia Edu	17
7	Arxiv	16
8	MDPI	14
9	CEEOL	13
10	Atlantis Press	12

The table presents the top 10 publishers in the Social Science category based on the total number of articles published. It highlights the dominance of major academic publishers, with Springer leading the list by publishing 118 articles. Springer is a well-known publisher that covers a broad range of disciplines, particularly in social sciences, humanities, and natural sciences. Following closely is Elsevier, which has contributed 75 articles, reinforcing its reputation as one of the largest and most influential publishers in academia. In the third and fourth positions, Taylor & Francis and Wiley Online Library have published 47 and 42 articles, respectively. These two publishers are widely recognized for their extensive portfolio of peer-reviewed journals and books, particularly in the fields of social sciences, education, and humanities. Their strong presence in this dataset indicates their significant role in disseminating research within the social sciences discipline. Other notable publishers include Books Google (29 articles), Academia.edu (17 articles), and Arxiv (16 articles). These platforms differ from traditional academic publishers, as Google Books serves as a digital repository, while Academia.edu and Arxiv provide open-access alternatives for researchers to share their work more widely. This highlights the growing influence of digital and open-access platforms in academic publishing. Additionally, MDPI, CEEOL, and Atlantis Press have also contributed to the dataset, with 14, 13, and 12 articles, respectively. MDPI is particularly known for its open-access model, making research more accessible to a global audience. CEEOL (Central and Eastern European

Online Library) focuses on regional research publications, while Atlantis Press is recognized for conference proceedings and academic books. Open academic platforms such as ERIC, SSRN, ResearchGate, and CyberLeninka also appear in this dataset, indicating that research is not only published through traditional publishers but also through open-access repositories. Overall, the distribution of publishers in this dataset shows that the majority of research is published by major academic publishers, while a portion is disseminated through open-access platforms. This reflects the current dynamics of academic publishing, where research accessibility is increasing with the rise of various online repositories and open-access journals.

2.2. Distribution of Data Related to AI in Natural Science Research

The dataset on the distribution of natural science topics presents citation metrics for journals published between 2020 and 2025. Over this five-year period, a total of 999 journals were recorded, accumulating 101,277 citations. The average number of citations per year is 20,255.40, while the average citations per journal amount to 101.38. On average, each author receives 40,178.73 citations and contributes to approximately 402.33 journals, with an average of 3.60 authors per journal. The h-index of 147 indicates that 147 journals have received at least 147 citations. Meanwhile, the g-index of 281 signifies that 281 journals have a cumulative citation count at least equal to the square of their ranking. Additionally, the dataset reports an hI,norm of 88, an hI,annual of 17.60, and an hA-index of 85—all of which represent variations of the h-index, adjusted based on citation averages. These metrics highlight the high academic impact and influence of the research published within this timeframe.

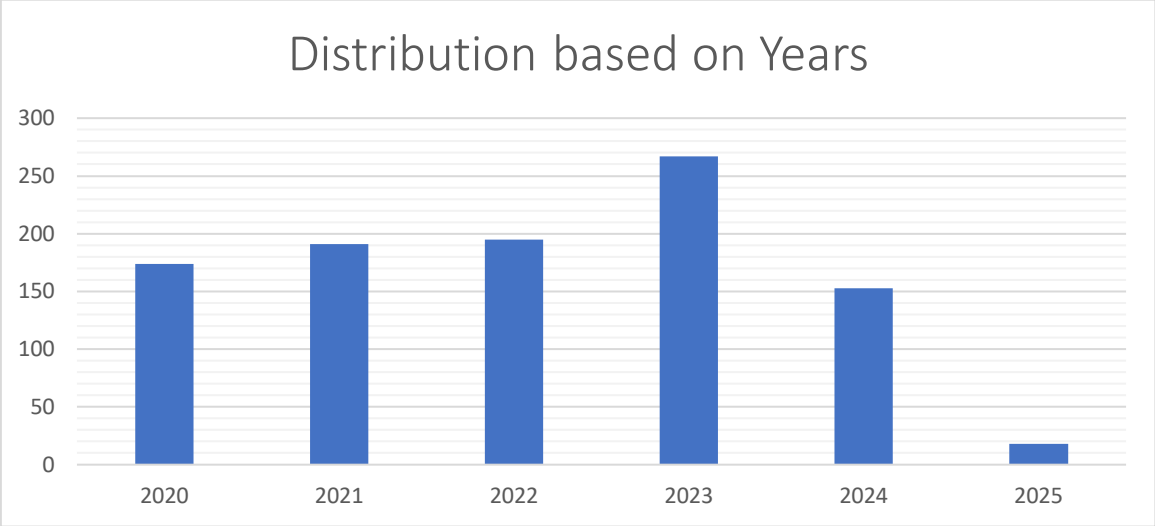

Figure 3: Distribution of Natural Science Articles based on Years

The analysis of publication trends based on the year of publication shows a significant increase from 2020 to 2023, followed by a slight decline in 2024. In 2020, there were 174 articles, accounting for 17.2% of the total publications in this dataset. This number increased in 2021 to 191 articles (18.9%), indicating a positive trend in scientific publications. In 2022, the number of published articles reached 195, representing 19.3% of the total publications. Although the increase was not as substantial compared to the previous year, the trend still demonstrated steady growth in research output. The peak of publications occurred in 2023, with 267 articles published (26.4%), making it the most productive year in this dataset. However, in 2024, the number of publications slightly declined to 154 articles (15.2%). This decline could be attributed to various factors, such as

changes in publication policies, shifts in research trends, or other external influences. Meanwhile, for 2025, there are currently 18 articles (1.8%) recorded, though this figure may not yet reflect the final total as publications for the year are still in progress. Overall, this trend demonstrates a year-over-year increase in publications, particularly with a significant surge in 2023, before experiencing a slight decline in the following year. With a clear distribution of percentages, this trend provides valuable insights into the dynamics of scientific publishing and the factors influencing research productivity across various fields.

Table 2: Top 10 publishers in the Natural Science category for this study

No	Publisher	Total Articles
1	Springer	166
2	Elsevier	103
3	Nature	94
4	Wiley Online Library	57
5	IEEE Xplore	54
6	MDPI	47
7	Google Books	32
8	Taylor & Francis	26
9	Frontiers	26
10	ResearchGate	25

The analysis of publisher distribution in this dataset reveals that scientific publications are dominated by major global publishers with strong reputations. Springer emerges as the leading publisher, with 166 articles, solidifying its position as one of the most prominent academic publishers across multiple disciplines, ranging from science to humanities. In second place, Elsevier has published 103 articles, making it one of the most influential publishers in the fields of science, technology, and medicine. Nature ranks third with 94 articles, indicating that a substantial portion of the research in this dataset has been published in prestigious journals managed by Nature Publishing Group. Additionally, Wiley Online Library and IEEE Xplore have significant publication counts, with 57 and 54 articles, respectively. While Wiley is widely used in science, social sciences, and engineering, IEEE Xplore primarily focuses on engineering, computing, and information technology. MDPI, known for its open-access publishing model, also plays a notable role, with 47 articles published through its platform. Other publishers contributing to the dataset include Google Books (32 articles), Taylor & Francis (26 articles), and Frontiers (26 articles). Meanwhile, ResearchGate, a community-based platform, has published 25 articles, highlighting its role in enabling researchers to share their findings more openly. Overall, the distribution of publishers in this dataset showcases the dominance of major academic publishers with high-quality standards. Springer, Elsevier, and Nature.com are the top three publishers responsible for the majority of articles, while MDPI and IEEE Xplore also play a crucial role in providing access to research across various fields. This distribution further indicates that a significant portion of research is disseminated through platforms that maintain rigorous quality standards and have a global reach.

3. Discussion

3.1. AI in Social Research

Social sciences rely on various methods, including questionnaires, behavioral tests, mixed-methods analysis from semi-structured research, agent-based modeling (ABM), observational studies, and experiments. The primary goal is to obtain a general representation of individual, group, and cultural characteristics, as well as their dynamics (Babalola & Nwanzu, 2021; Grossmann, 2023; Mandavilli, 2024). With the emergence of advanced AI systems, the landscape of data collection in social sciences is subject to change (Grossmann et al., 2023; Saheb & Saheb, 2024). Overall, the potential of AI in social research offers new ways to understand and analyze complex social phenomena, while also providing the necessary tools to assist researchers in processing data, testing hypotheses, and generating insights that are valuable for policy and social practices (Franco & Santurro, 2021; Hasas et al., 2024; Maghsoudi et al., 2025).

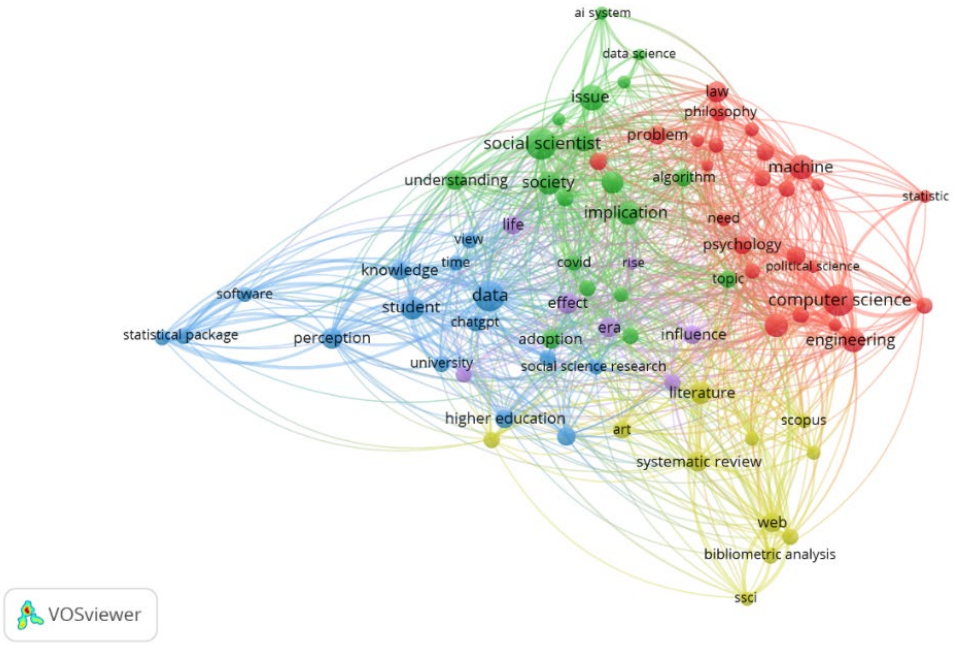

Figure 4: Network Visualization of AI in Social Sciences

Figure 2 presents a network visualization using VOSviewer, illustrating the relationships between keywords in articles discussing artificial intelligence (AI) in relation to social sciences. This visualization highlights how various aspects of social sciences and technology are interconnected in AI research.

The blue cluster focuses on the **educational aspects and perceptions of AI**, featuring keywords such as **"student," "knowledge," "perception," "higher education,"** and **"university."** This indicates that many studies explore how AI is applied in education and how students and academics perceive and respond to this technology.

Adjusting educational strategies to accommodate different cultural perspectives, provide tailored support, and ensure user-friendly interactions is essential in fostering positive attitudes and intentions toward AI, particularly among students (Ma et al., 2024; Payadnya et al., 2025; Yusuf et al., 2024). Today's students have excellent opportunities to learn in interactive and personalized environments, and AI significantly facilitates both aspects. AI, trained on big data, can provide personalized learning experiences for students. At the same time, professors can explore new

teaching approaches and adjust their methods to align with student needs (Kuleto et al., 2021; Liu & Quan, 2022; Mondal et al., 2024). AI applications in higher education have the potential to enhance instructor engagement and encourage positive attitudes toward integrating new technologies into teaching, learning, and assessment practices (Rahiman & Kodikal, 2024). Exposure to and experience with AI are key determinants shaping individual perspectives. Aligning AI goals with educational objectives and effectively addressing related challenges have been identified as critical factors in fostering positive attitudes and perceptions (Al-Zahrani & Alasmari, 2024).

The green cluster highlights the **social impact of AI**, with keywords such as **"social scientist," "society," "implication," "issue," "AI system,"** and **"data science."** This cluster emphasizes that AI is not merely a **technological development** but also has profound **societal, ethical, and social science implications**. The study of AI in a **social context** is increasingly relevant to **ensure its development and application** are **fair and beneficial to all**.

Society is currently undergoing rapid digital transformation (Akour & Alenezi, 2022; Bounfour, 2016; Muwani et al., 2022). AI enhances information accessibility, allowing individuals to search and retrieve answers effortlessly (Bulfamante, 2023; Haque & Li, 2024; Modiba, 2024; Naamati-Schneider, 2024). In the near future, AI is likely to transform not only workplace operations but also daily life. In general, future societal prosperity may depend on how well societies adapt to the transformational changes brought by the AI revolution (Caruso, 2018; Farina et al., 2024; Li, 2020). Therefore, social scientists have a responsibility to collaborate creatively in identifying societal challenges and proposing solutions while embracing the benefits of science and technology (Fischer et al., 2005; Graesser et al., 2018; H. Wang, 2020).

The red cluster is closely related to **computer science and engineering**, including keywords such as **"machine," "algorithm," "engineering," "psychology," "political science," "philosophy,"** and **"law."** This indicates that AI research in **social sciences** extends beyond its **impact on humans** to include **technical, ethical, and legal aspects** governing its use.

AI has influenced numerous industries, including law. The intersection of AI and law is reshaping regulatory frameworks, bringing both benefits and challenges (Khan, 2024; Lescrauwaet et al., 2022; Marwala & Mpedi, 2024). Ethics serves as a fundamental pillar in AI development, outlining key principles such as transparency, fairness, privacy, accountability, and beneficence (González et al., 2024; Nikolinakos, 2023; Radanliev, 2025). Additionally, developing AI algorithms free from discriminatory biases and promoting transparency and explainability in AI models are crucial for fostering trust and integrity. This requires the implementation of strong regulatory frameworks that prioritize data privacy, transparency, and ethical AI deployment (Akinrinola et al., 2024; Díaz-Rodríguez et al., 2023; Nadjia, 2024).

The yellow cluster focuses on **bibliometric analysis and literature reviews**, with keywords such as **"bibliometric analysis," "systematic review," "Scopus,"** and **"web."** This suggests that many studies seek to understand **AI research trends and patterns in social sciences** through **bibliometric approaches**.

For instance, Abuhassna et al (2024) conducted a bibliometric study on AI and machine learning (ML) integration. Their findings offer a comprehensive roadmap for educators, researchers, and policymakers, highlighting AI and ML's transformative potential in the education sector (Abuhassna et al., 2024). Similarly, Kang et al (2024) examined AI-based bibliometric research focused on AI applications in cartography, while Bahoo et al (2024) explored AI in finance using

bibliometric studies. These studies demonstrate that social sciences are increasingly integrating bibliometric approaches, with potential for deeper exploration in the future.

In this visualization, keywords such as "data" and "implication" serve as connection points between various clusters. This highlights the central role of data in AI research within social sciences, spanning its application in education, social analysis, and legal/policy frameworks. Keywords like "ChatGPT" also appear, reflecting growing interest in generative AI within educational and social interaction contexts.

Overall, this visualization reinforces that AI research in social sciences extends beyond technology itself to explore how humans, institutions, and policies respond to its advancements. The connections between AI and fields such as philosophy, law, politics, and psychology indicate the necessity of a multidisciplinary approach to comprehensively understand AI's far-reaching impacts. As a result, AI research in social sciences continues to expand with more comprehensive approaches, integrating multiple perspectives to address both challenges and opportunities in the digital age.

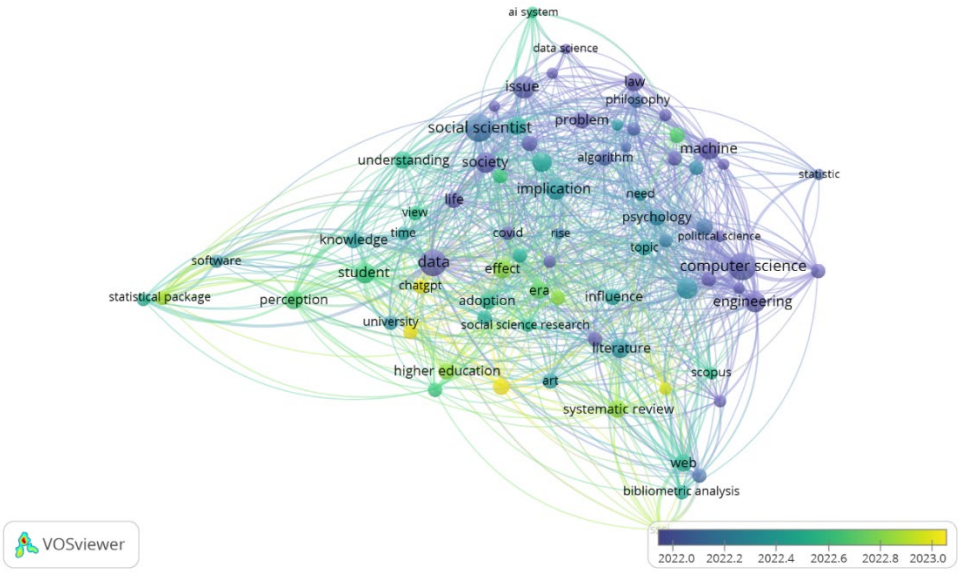

Figure 5: Overlay Visualization of AI in Social Sciences

Figure 3 presents an overlay visualization of keyword relationships in AI research within social sciences. This visualization illustrates topic evolution over time, with a color scale ranging from blue (earlier, around 2022) to yellow (more recent, around 2023).

From this visualization, it can be seen that some of the keywords in purplish blue, such as computer science, engineering, law, philosophy, and political science, indicate that AI-related research in the context of social science has previously focused more on technical aspects, regulation, and ethical and legal implications. This indicates that early research highlighted AI from classic academic perspectives such as computer science and policy. Over time, the research trend shifted towards a greener to yellow direction, with new topics being more relevant in 2023. Keywords such as 'ChatGPT', 'adoption', 'higher education', 'university', and 'systematic review' indicate that AI is now starting to be discussed more in the context of education and its adoption in academic institutions. The appearance of ChatGPT in yellow indicates that generative AI technology is a growing focus of research recently.

Keywords such as 'student', 'perception', 'knowledge', and 'higher education' are colored green-yellow, indicating that in the past year, AI research in the social sciences has increasingly focused on how AI affects higher education, both in terms of acceptance by students and its use in learning. In addition, the associations with social scientist, influence, literature, and systematic review indicate that AI studies in the social sciences are increasingly oriented towards literature review and research trend mapping. Keywords such as web, bibliometric analysis, and scopus are also colored more yellow, indicating an increase in research based on bibliometric data to understand the impact of AI in various social fields.

Overall, this overlay visualization shows a shift in focus in AI research in the social sciences. Whereas in previous years studies have focused on technical, regulatory, and ethical aspects, the recent trend has been towards AI adoption in education, societal acceptance, and bibliometric studies to understand its broad impact. With the emergence of generative AI such as ChatGPT, AI research in the social sciences will further evolve towards exploring the impact of this technology in learning, social interaction, and the transformation of higher education. In the future, it is likely that research will continue to develop on aspects of user experience, adaptation in the curriculum, and the ethics of using AI in various fields of social science.

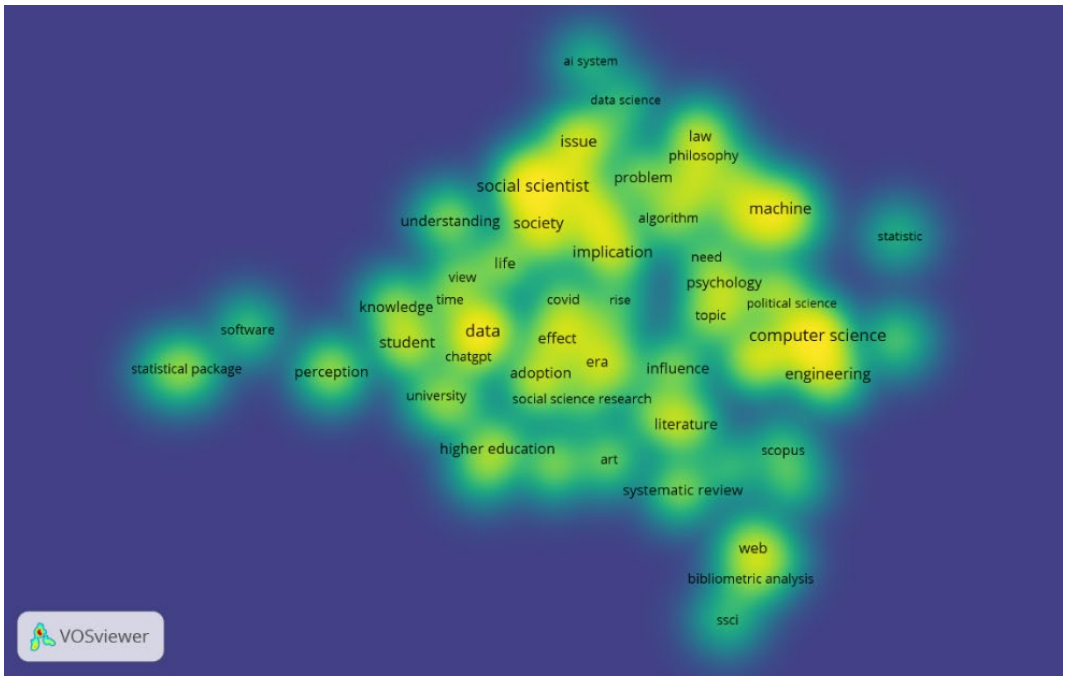

Figure 6: Density Visualization of AI in Social Sciences

Figure 4 is a density visualization of the keyword analysis in AI-related research related to social science. This visualization shows the density or frequency of occurrence of keywords in the analyzed literature, where yellow indicates areas of high density (hotspots), while green and blue indicate areas of lower density.

From this visualization, it can be seen that the bright yellow areas are around keywords such as ‘data’, ‘student’, ‘adoption’, ‘computer science’, ‘engineering’, and ‘machine’. This indicates that these topics are the center of attention in AI research related to social science. The word data takes center stage, indicating that the utilization and analysis of data in a social context is the most researched aspect. In addition, the word adoption is also a high-density area, which means that many studies address how AI is being adopted in various aspects of social science, including in education

(higher education, student, university). This confirms the trend that many AI studies in social sciences focus on the acceptance and integration of AI technologies in academia.

Some of the medium-density keywords (colored green-yellow) are ‘implication’, ‘psychology’, ‘perception’, ‘influence’, and ‘law’. This shows that although not as dense as the main topics, these aspects remain a significant part of AI research in the social science field. For example, psychology and perception indicate an interest in how AI affects human mindset, behavior, and interactions. While implication and law indicate that research is also highlighting the ethical, legal, and policy impacts of AI.

Green to bluish sections indicate less researched topics in the analyzed literature. Some keywords such as 'art', 'systematic review', 'bibliometric analysis', 'statistical package', and 'software' fall into this category. This suggests that while there is research on AI in the context of art and systematic review and bibliometric analysis, the frequency is not as great as in other fields such as education and engineering. In addition, the role of software and statistical packages does not seem to be a major focus in AI research in the social sciences.

Based on this density visualization, it can be concluded that AI research in the social sciences is still very much focused on the data-driven aspect, with the main concern being the acceptance of AI in education and its social impact. Issues such as the psychology, law, and ethics of AI are also starting to develop, although not as high as the main topics. In the future, AI research in the social sciences is likely to expand further towards studying the long-term impact of AI on human interaction, public policy, as well as aspects that currently receive less attention, such as AI's relationship with art and systematic studies.

Table 3 Categorization Results of AI in Social Science Research

Category	Keywords	Analysis
Technology and Computer Science	*computer science, engineering, machine, algorithm, data science, AI system, software, statistical package*	- AI is closely related to the development of computer science and technology. - Overlay visualization shows the most developed trend range (Between 2022 to 2023). - Density visualization shows that this category has a high density in the study.
Higher Education	*student, university, higher education, knowledge, perception, adoption*	- AI is widely studied in the context of education and learning in higher education. - The trend of AI adoption in higher education is increasing. - Density visualization shows that this field is quite dominant.
Social and Ethical Impact	*social scientist, society, implication, influence, issue, psychology, perception, law, philosophy*	- AI is studied from social, psychological, legal, and ethical perspectives. - Attention to social issues is increasing (overlay visualization). - Density visualization shows lower density compared to technology and education categories.
Bibliometric Methods and Analysis	*systematic review, bibliometric analysis, web, scopus, SSCI, literature*	- AI studies in the social sciences also use bibliometric analysis and systematic reviews. - Overlay visualization shows that this method is still evolving. - Density visualization shows a fairly wide distribution of topics but not as dense as other categories.

Thus, the utilization of AI in social research has potential in social research. From this table, it can be concluded that AI in social science has strong links with technology and education, while social impact studies and research methodologies continue to evolve.

4. AI in Natural Research

Natural resources are scarce and require efficient management to achieve sustainable goals (Bringezu et al., 2016; Mondal & Palit, 2022; Wan et al., 2022). Natural resources must be managed efficiently so that current generations can meet their needs while preserving them for future generations (Feng et al., 2023; Shah et al., 2023). In the era of climate change, this is becoming increasingly important (Pandey et al., 2023). The use of AI in natural resource management began with the development of expert systems for problem solving and decision making (Coulson et al., 1987).

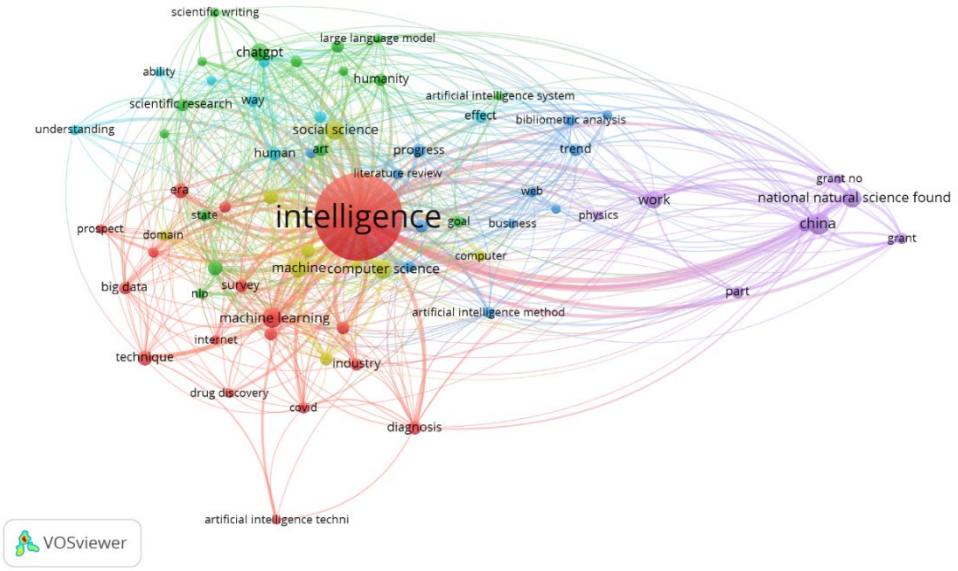

Figure 7 Network Visualization of AI in Natural Sciences

This network visualization analysis reveals the linkages between artificial intelligence (AI) and various fields of science, especially in the context of natural sciences. Based on the network structure, there are several main clusters that reflect how AI is evolving and impacting various sectors.

The first cluster focuses on AI technologies and their application in healthcare and industry. Key concepts in this cluster include machine learning, natural language processing, and the utilization of big data in various sectors. AI has become an important tool in disease diagnosis, drug discovery, and industrial production optimization. In healthcare, AI helps analyze large-scale medical data to detect diseases more quickly and accurately. In the industrial sector, AI is used for process automation and work efficiency improvement.

AI in the healthcare sector is receiving attention from researchers and healthcare professionals (Bohr & Memarzadeh, 2020; Lee & Yoon, 2021; Secinaro et al., 2021). Interest and advancements in medical AI applications have surged in recent years due to the substantially increased computing power of modern computers and the vast amount of digital data available to be collected and utilized (Haleem et al., 2022; Meskó et al., 2017; Thacharodi et al., 2024; Tripathi et al.,

2021). Research by Sunarti et al (2021) explained that the implementation of AI is necessary in the efficiency of healthcare management as well as medical decision-making. The challenge is to facilitate early adoption and sustainable implementation in the healthcare system, and we consider a list of ethical issues faced by clinical applications of AI. In the medical domain, AI mainly focuses on developing algorithms and techniques to determine whether the system behavior is appropriate in disease diagnosis (Ahsan et al., 2022; Sarker, 2022). A medical diagnosis identifies a disease or condition that explains a person's symptoms and signs. Usually, diagnostic information is gathered from the patient's history and physical examination (McPhee & Papadakis, 2009).

The second cluster highlights the impact of AI in the social sciences and humanities. The technology is not only limited to technical aspects, but also affects social dynamics, art, and human-machine interaction. The presence of keywords such as ChatGPT and large language model shows how AI has evolved in natural language processing and its use in the fields of scientific writing and digital communication. In addition, AI plays a role in social research to understand human behavior patterns and the impact of technology on society.

Researchers are increasingly realizing that cognition and emotion processes interact and their neurological mechanisms are integrated within the brain to mutually influence behavior (Bhatt et al., 2023; Braver et al., 2014; Okon-Singer et al., 2015). Human behavior reflects cognitive abilities. Human cognition is essentially related to different experiences or characteristics of consciousness/emotion, such as joy, sadness, anger, etc., which helps in effective communication with others (Bhatt et al., 2023; Izard, 2013; Jinnuo et al., 2025; Ortony, 2022). Research reveals that effective human-AI interaction requires a framework that evaluates real-world interactions rather than assessing AI systems in isolation, as human behavior patterns significantly affect AI performance and outcomes (Ibrahim et al., 2024; Sun et al., 2024). An alarming “AI Divide” is emerging among global regions, potentially exacerbating existing inequalities in technology access and benefits (Santos & Jamil, 2024). While some AI systems exhibit disruptive behavior patterns similar to antisocial tendencies (Ogilvie, 2024), others show potential for positive applications, including enhancing children's empathy development (Wu et al., 2020), improving project management effectiveness (Lawal et al., 2024), dan and transforming media consumption through collaborative reading tools (Chen et al., 2023).

The third cluster deals with scientific research and evaluation of AI, including research trends and applications of AI in business and economics. AI is used in market analysis, data-driven business strategies, and smarter decision-making. In addition, bibliometric studies show that AI has become a major focus of academic research. Many studies seek to understand the challenges, opportunities, and long-term impact of AI technologies in various fields.

Market analysis has evolved dramatically from the traditional reliance on historical data, manual surveys, and expert interpretation to sophisticated AI-based approaches that can process diverse data streams in real-time (Pattanayak, 2022; Qayyum et al., 2025). Studies show a substantial increase in AI adoption, with German companies alone showing growth from 6% in 2020 to 13.3% in 2023, and projections showing significant economic impact by 2030 (Abdelaal, 2024). This market analysis is packaged through scientific mapping in the form of a bibliometric study. Performance analysis and scientific mapping techniques are often used to investigate co-authorship patterns, keyword co-occurrence, citation networks, bibliographic merging, and co-citation analysis (Alkoud et al., 2024). These methods collectively provide a multidimensional perspective on the research

landscape, allowing researchers to identify influential contributors, emerging themes, and collaborative ecosystems in AI research.

The fourth cluster highlights China's role in AI research and development, supported by various national funding programs. Keywords such as national natural science found and grants indicate heavy investment in AI research, especially in natural science fields such as physics. This confirms that AI not only impacts the technology industry, but also contributes to advanced scientific research, such as predictive modeling in physics and other experimental sciences.

China recognizes artificial intelligence as a crucial battleground in technological competition and the national economy. The government has incorporated AI development into its highest-level strategic planning, with AI identified as a key driver for local innovation capacity (Abrams, 2022; Atkinson & Atkinson, 2024; Bai et al., 2021). The “New Generation Artificial Intelligence Development Plan” serves as the basic policy document guiding China's AI funding ambitions and priorities (Khanal et al., 2025; Luong & Fedasiuk, 2022; 高芳, 2018). The research funding system in China, including AI, is supported by various government agencies and programs. The National Natural Science Foundation of China (NNSFC) is a key player, providing grants for scientific research across disciplines, including AI (Tao et al., 2024; F. Wang et al., 2025). This is especially true in the field of physics. AI plays an important role in computational physics, such as in high-energy physics where it helps with simulation and data analysis (He et al., 2023; Jiao et al., 2024; Pang, 2024). However, the search results did not provide specific examples of AI applications in computational physics, but it is known that AI improves data-driven decision making and increases efficiency in various scientific domains (Hisham et al., 2024).

The results of this visualization are interesting because although the main keywords are related to natural science, it turns out that social science still has a strong connection. This shows that the development of artificial intelligence (AI) cannot be separated from social aspects, policies, and impacts on humans. AI is not only a tool in scientific experiments and mathematical calculations in the natural sciences, but also affects the way humans interact, think, and make decisions. For example, the presence of keywords such as social science, ChatGPT, and humanity in the visualization shows that AI is studied not only from a technical perspective, but also from a social and ethical perspective. This indicates that the study of AI is increasingly interdisciplinary, where natural and social sciences influence each other. In addition, the presence of AI in social science can help explain more complex social patterns with data-driven analysis. For example, the use of AI in bibliometric analysis shows how research is evolving and how trends in AI scholarship are influenced by various factors, including research policies and funding. The existence of clusters that highlight research funding (national natural science found and grants) also shows that AI development is not only determined by technological advances, but also by economic and policy aspects. Thus, while the natural sciences remain the main foundation in the development of AI, the social sciences still have an important role in understanding, directing, and managing the impact of this technology on human life. This confirms that in the age of AI, a multidisciplinary approach is becoming increasingly important to ensure that technology develops in a beneficial and sustainable way.

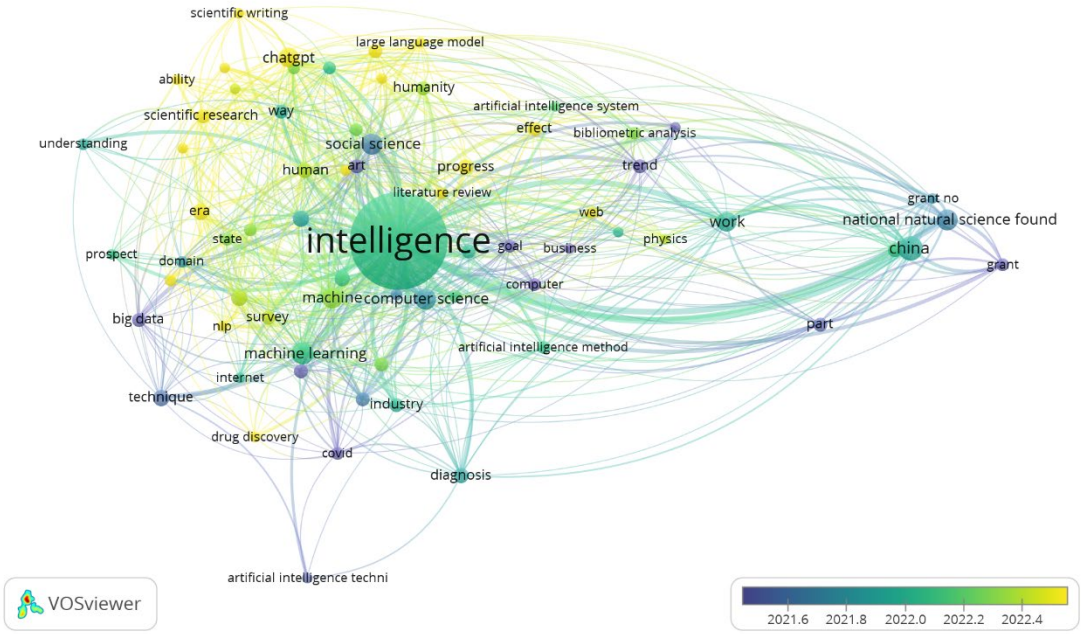

Figure 8: Overlay Visualization of AI in Natural Sciences

This overlay visualization illustrates the development of artificial intelligence (AI) research over time. The colors in the visualization indicate the period of research, where blue represents earlier publications (around 2021), green indicates emerging research (2022), and yellow reflects newer and rising trends (2023-2024). From the pattern formed, it can be seen how the focus of AI research is shifting from basic technology to its application in various fields of science and human life.

In the early period around 2021, AI research is mostly concerned with technical aspects and the development of basic methods in artificial intelligence. Concepts such as machine learning, big data, and artificial intelligence methods take center stage, indicating that at this stage AI is still being developed as a major tool in data processing and predictive analysis. In addition, the health and industrial fields began to apply AI, especially in the process of diagnosing diseases and optimizing production processes. During this period, China also played a major role in the development of AI, as shown by the research funding that supports the advancement of this technology.

Entering 2022, research began to shift in a broader direction, covering human interaction with AI as well as its utilization in social science and communication. The emergence of concepts such as ChatGPT, large language models, and scientific writing signaled that AI was no longer just being used in data analysis, but also in the fields of language, scientific research, and digital communication. During this period, AI was increasingly applied in social and humanities research, where researchers sought to understand how this technology could contribute to the analysis of human behavior and information production.

In 2023 to 2024, the trend of AI research will further develop towards scientific innovation and multidisciplinary transformation. The yellow color in the visualization shows that current research focuses more on the integration of AI in various fields of science, including arts, humanities, and data-driven scientific research. Concepts such as scientific research, progress, ability, and

humanity show that AI now plays a role not only as a technological tool, but also as a key element in scientific development and decision-making.

In terms of time progression, it can be estimated that from 2021 to 2022, research still focuses on basic AI concepts such as machine learning, big data, and the application of AI in healthcare and industry. In this period, many studies highlight how AI can be used in drug discovery, disease diagnosis, and in improving business efficiency. Entering 2022 to 2023, AI research trends began to shift towards natural language processing and large language models, as seen from the emergence of the terms ChatGPT and large language models. During this period, AI was increasingly used in scientific analysis, academic writing, and social sciences, indicating that its impact is expanding. Business and industry are also increasingly adopting AI, with more and more research addressing how AI affects jobs and economies globally.

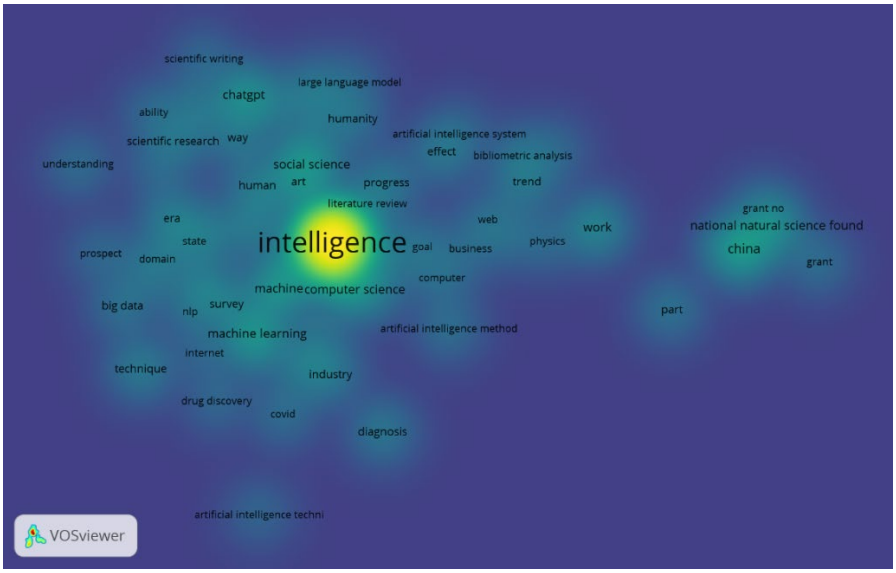

Figure 9: Density Visualization of AI in Natural Sciences

This density visualization shows how various terms in artificial intelligence (AI) research are interconnected and evolving over time. Lighter colors indicate terms with a higher frequency of occurrence in the scientific literature, while darker colors indicate terms with a lower frequency. From this visualization, it can be seen that the term intelligence is the main hub of AI research, with many other terms directly related to it, such as machine learning, computer science, and artificial intelligence methods. This shows that AI research is still very much focused on the development of machine learning algorithms and the application of AI in various fields of computer science.

As AI develops, new trends are beginning to emerge, especially in the fields of natural language processing and large language models. Terms such as ChatGPT and large language models indicate that research is increasingly focusing on how AI can be used to understand and generate natural language. This shows a shift from research focusing on the technical aspects of AI to a more applied direction, especially in human-machine interaction. In addition, AI is also increasingly being applied in the social sciences and scientific research, as seen from terms such as social science, scientific research, bibliometric analysis, and scientific writing. This indicates that AI is now being used not only in the world of technology, but also in understanding and analyzing social phenomena and assisting in the production of scientific papers.

Table 4: Categorization Results of AI in Natural Science Research

Category	Keywords	Analysis
Key Concepts of AI	*intelligence, machine learning, computer science, artificial intelligence method, artificial intelligence system*	- AI is becoming a major center of research and has many links to various fields. - The overlay visualization shows that this key trend is growing since 2021 and getting stronger in 2022-2023. - Density visualization shows a high density around this concept, indicating the dominance of related research.
Large Language Model and Natural Language Processing	*ChatGPT, large language model, NLP, scientific writing, bibliometric analysis, literature review*	- Rapid increase in research related to large language models and NLP, especially since 2022. - Overlay visualization shows yellow in these terms, indicating recent trends. - Density visualization shows medium density, indicating an area of research that is growing but not yet as dominant as major AI concepts.
Social and Humanities Impact	*social science, humanity, art, human*	- AI is starting to play a role in social sciences, arts, and ethical studies. - Overlay visualization shows a green-yellow color, indicating an upward trend from 2022. - Density visualization has a low density, indicating that the field is still developing and not as big as technical fields.
AI in Industry and Business	*industry, business, work, internet, big data*	- AI is widely used in business and industry for efficiency and big data processing. - Overlay visualization shows that this research started to increase from 2021-2022. - Density visualization shows medium density, indicating that despite its importance, this research is not as dominating as AI in computer science.
AI in Health and Science	*drug discovery, diagnosis, covid, physics*	- AI is increasingly being used in the medical and scientific fields, especially since the COVID-19 pandemic. - Overlay visualization shows that this trend started in 2021 and is still growing. - Density visualization shows medium density, indicating that this field is significant but not as big as AI in industry or NLP.
Geopolitics and Funding Factors	*China, grant, national natural science found, grant no*	- The role of the state and funding in AI research is growing, with China as one of the leaders. - The overlay visualization shows that this geopolitical aspect has already emerged before 2022 but is continuing. - The density visualization has a medium density, indicating that while important, this factor is not as dominating as the main AI concepts.

In addition to applications in the academic and social fields, AI is also increasingly being used in industry and the world of work. Terms such as industry, business, and work indicate that AI technology is being adopted by various business sectors to improve efficiency and productivity. AI is also being used in health and science, as seen from the terms drug discovery, diagnosis, and covid. This shows that AI plays an important role in drug development, disease diagnosis, and handling the COVID-19 pandemic. In the field of science, AI is starting to be used in physics research, which is reflected in the term physics, showing that AI has great potential in supporting various disciplines.

This visualization also shows that geopolitical factors and funding play a role in AI development. Terms such as China, grant, and national natural science found indicate that AI research receives significant support from government funding, especially from China. This indicates that major countries are starting to compete in AI development as part of their national strategies. Large funding allows AI research to progress faster, both in academic aspects and industrial applications.

Overall, this visualization shows that AI continues to evolve from basic concepts to broader applications in various fields. Recent trends show an increase in research in large language models, natural language processing, and the application of AI in social sciences and industry. In addition, funding and geopolitical factors also have a significant influence on the development of AI research. With the widespread adoption of AI in various sectors, this technology will continue to experience rapid development and have a greater impact on human life in the future.

From this analysis (who can be seen on the Table 4), it can be concluded that AI has developed rapidly in various aspects, from its technological fundamentals, applications in industry, to its impact on social life and geopolitics. The dominance of terms such as "intelligence" and "machine learning" shows that the basic concepts of AI are still the main foundation, while new trends such as large language models (LLMs) are on the rise since 2022. In addition, the use of AI in healthcare and industry indicates that this technology is increasingly playing a role in real life. China has also emerged as one of the major actors in AI development, reflecting the global competition in this field.

Conclusion

This study provides conclusions on two related fields. First, for the social field, it can be concluded that (1) AI is closely related to computer science and engineering, which is the main foundation for its application in the social science field, (2) AI is increasingly used in education, especially in improving the learning experience of students and universities, (3) studies on the social impact of AI continue to grow, with close links to law, psychology, and philosophy, and (4) bibliometric analysis methods and systematic reviews are increasingly used to understand AI research trends in the social sciences. As for the natural field, the conclusions include (1) AI is a dominant topic in research, with broad connections to various fields, both technical and social, (2) Large language models and natural language processing are growing rapidly, especially in the context of academic and scientific literacy, (3) AI is not only a technological phenomenon, but also has a broad impact on the social sciences, arts, and humanities, (4) AI is not only a technological phenomenon, but also has a broad impact on the social sciences, arts, and humanities, (4) AI is increasingly applied in industry and business, especially for efficiency and big data processing, (5) AI plays an important role in healthcare and scientific research, especially in diagnosis and drug discovery, (6) Geopolitical factors and funding have a major impact on the development of AI research in various countries, with China having an early start.

Based on the results of the study, there are several recommendations for researchers in the social and natural fields related to the development and impact of artificial intelligence (AI). For researchers in the social field, there are several aspects that can be further explored. First, research on the impact of AI on society needs to be expanded, especially in the aspects of psychology, human behavior, ethics, and legal regulations. This is important as AI is increasingly affecting our daily lives, including privacy rights and digital inequality. Secondly, in the field of education, AI is increasingly being used to improve students' learning experience. Therefore, research that addresses the effectiveness of AI in learning, personalization of education, and its impact on lecturer and student interactions is highly relevant. In addition, research on AI regulation and policy is also crucial to anticipate the various legal and social implications that may arise from the widespread adoption of AI. Finally, the use of bibliometric methods and systematic reviews are increasingly important in the social sciences to understand the patterns of AI research development and identify under-explored trends.

Meanwhile, for researchers in the natural field, several key recommendations can be made. First, the development of AI technology needs to continue with a focus on improving efficiency, transparency, and ethics. The use of explainable AI (XAI) is one solution to increase public trust in AI systems. Second, natural language processing (NLP) and the development of large language models (LLM) such as ChatGPT are growing rapidly. Therefore, research on improving accuracy, mitigating bias in AI models, and applying NLP in multiple languages are important to make this technology more inclusive. AI also has a growing role in science and healthcare, especially in disease diagnosis and drug discovery. Further research is needed to ensure the accuracy and security of medical data used in health AI. The use of AI also raises specific concerns regarding research and publication ethics, which can lead to bias, inaccurate information, and plagiarism. Therefore, regulations addressing ethical concerns and privacy in scientific writing are necessary, along with building awareness about the importance of respecting others' privacy and rights.

In industry and business, AI is increasingly being applied to improve work efficiency, but research on its impact on the workforce is needed. AI can also contribute to environmental sustainability, so research related to the application of AI in green technology can be a promising research opportunity. In addition, geopolitical factors and funding have a major impact on the development of AI globally. Countries such as China are already competing in AI development through dominating research, so research on the impact of policies and funding on AI development is a promising research opportunity.

Overall, AI research is not only related to the technological domain but also has far-reaching impacts on society. Therefore, collaboration between social scientists and natural scientists is necessary to ensure that the development of AI is beneficial, ethical, and inclusive for all.

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